

Report Documentation Page			Form Approved OMB No. 0704-0188		
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE <b>30 SEP 2013</b>	2. REPORT TYPE		3. DATES COVERED <b>00-00-2013 to 00-00-2013</b>		
4. TITLE AND SUBTITLE <b>ONR Progress Report: 2013 Contract</b>			5a. CONTRACT NUMBER		
			5b. GRANT NUMBER		
			5c. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S)			5d. PROJECT NUMBER		
			5e. TASK NUMBER		
			5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) <b>University of Washington, Applied Physics Lab, Seattle, WA, 98195</b>			8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSOR/MONITOR'S ACRONYM(S)		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT <b>Approved for public release; distribution unlimited</b>					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT <b>Same as Report (SAR)</b>	18. NUMBER OF PAGES <b>2</b>	19a. NAME OF RESPONSIBLE PERSON
a. REPORT <b>unclassified</b>	b. ABSTRACT <b>unclassified</b>	c. THIS PAGE <b>unclassified</b>			

## **ONR Progress Report: 2013 Contract:**

Mark Wensnahan  
Applied Physics Lab  
University of Washington  
Seattle, WA 98195  
206-706-4891 [thinice@apl.washington.edu](mailto:thinice@apl.washington.edu)

This contract covers the processing and analysis of US Navy submarine measurements of sea-ice draft in the Arctic. Work in 2013 under this grant consisted of 4 basic tasks: (a) a regression analysis of the effect of ship depth and speed on mean draft and other statistics, (b) development of software to process both digital and analog data, (c) processing and analysis of data from two cruises in 2011 and (d) beginning processing of older analog data.

### **Regression Analysis**

An analysis of analog data from the National Snow and Ice Data Center (NSIDC) public archive was performed to determine what impact ship depth and speed have on the ice draft data. In the future it is likely that submarines will be traveling at greater depth and higher speeds, potentially degrading the data and introducing bias. A regression analysis of mean draft, draft mode and the standard deviation of the mean as a function of time of year, location, year and ship depth and ship speed was conducted. The analysis showed that there was no dependence of the draft on ship depth and hence no bias was introduced due increased footprint size. Surprisingly there was a statistically significant dependence of draft with speed. This appears to be due to overwriting of the analog charts. It is not clear if these results hold for the digitally-recorded first return data as those data do not include information on speed or depth. It was concluded that a digital recorder which records the entire return pulse would provide the best quality data for now and into the future. A technical report on this matter has been submitted to the NSIDC archive.

### **Software Development**

Software was needed to process a number of cruises worth of digitally recorded data. It was necessary to build the software from scratch as no existing software was available. The software displays data, allows the user to define calibration points, and allows the user to mark data for exclusion from the final product. With this input it produces an edited and calibrated product suitable for inclusion in the NSIDC archive.

Software exists to process certain kinds of analog strip chart data. It was necessary to modify the existing software to allow processing of two other types of charts. Modifications included (a) ability to process rectilinear chart data rather than curvilinear, (b) determination of chart wander in the scanned image, (c) inversion of scanned images and (d) contrast and brightness adjustment of scanned images. This was a particularly time-consuming task given the complex nature of the software.

## **Processing of 2011 data**

Data from two cruises during 2011 were obtained from the US Navy Arctic Submarine Lab in San Diego. Initially the data were thought to be unusable but detailed study showed that the data could in fact be processed using software developed in the previous task. The draft data were compiled from spreadsheets while navigation data were compiled from a few different sources. Navigation and draft data were then merged and processed. One cruise had fairly high quality data that was straightforward to process. The other cruise had noisy data requiring a significant amount of editing. Ultimately several thousand kilometers of draft data were produced for two important routes through the Arctic. The data have been submitted to the NSIDC archive. The addition of these data to the archive will be advertised as part of a presentation at the Fall American Geophysical Union conference in San Francisco. The presentation will compare the 2011 data with previous submarine data, model output, and ice thickness products from the CRYOSAT-2 radar altimeter.

## **Processing of Analog Data**

Processing of analog data has begun. This processing was delayed by the extensive revision required for the existing processing software as detailed above. Much of two cruises from the 1970s has been completed. Processing involves a sequence of complex and painstaking steps to calibrate and edit the data then merge the data with navigation metadata. The processing is proving difficult for a number of reasons but is nonetheless proceeding. With each cruise processed, lessons are learned that allow improvements to be made to the already-processed cruises. Consequently, release of the data to the NSIDC archive is being held off for the moment in order to ensure the highest quality data is presented to the public.